2002 Program Evaluation

December 2002

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Missouri Department of Natural Resources
Air and Land Protection Division
Air Pollution Control Program

Executive Summary

The St. Louis area counties of St. Louis, St. Charles, Jefferson, and Franklin and the city of St. Louis are currently classified by the EPA as a "moderate ozone nonattainment area", pursuant to the Clean Air Act. This means monitored ambient air levels of ground-level ozone were above the existing health-based federal standards at the time of classification.[1] These standards are known as National Ambient Air Quality Standards. The Clean Air Act and federal regulations require moderate ozone nonattainment areas to implement a **basic** vehicle emissions inspection and maintenance (I/M) program in any urbanized area with a 1990 Census-defined population of 200,000 or more. However, in order to meet air quality goals, improve the health and quality of life of St. Louis area citizens, and meet federal standards, Missouri chose to implement an **enhanced** vehicle emissions I/M program.

In 1994, enactment of Senate Bill 590 authorized the Missouri Department of Natural Resources to establish a centralized, enhanced I/M program to replace the existing decentralized basic I/M program (BAR 90). (The BAR 90 I/M program had been established as part of the safety inspection requirement in the 1980s.) Litigation and difficulties in securing a contractor delayed implementation of the enhanced I/M program until 2000. The enhanced I/M program, known as the Gateway Clean Air Program, began operations in April 2000. The enhanced I/M program operates in the city of St. Louis, and all counties listed in the first paragraph with the exception of Franklin County. Franklin County has a centralized, basic I/M program, which also began operation in April 2000.

This report evaluates the performance of the enhanced I/M portion of the Gateway Clean Air Program relative to the federal Enhanced I/M Performance Standard, which is Missouri's target for achieving the necessary reductions in air pollution, and the federal Basic I/M Performance Standard, which is Missouri's binding commitment to EPA. This report also calculates the actual emission reductions achieved from the enhanced I/M program using the I/M program data collected during the first two years of operation, April 5, 2000, to December 31, 2001.

Two analyses are provided in this report. The first analysis method uses the MOBILE model to calculate the enhanced I/M program emission factors and compare them with the Basic and Enhanced I/M Performance Standards. The second analysis method uses the Gateway Clean Air Program test data to calculate the average reduction in emission factors on a fleet wide basis. If the results of both methods of analysis are complementary to each other and meet the stated goals, then the Gateway Clean Air Program will continue to be an EPA-approved I/M program.

The MOBILE model analysis indicates the enhanced I/M program is more effective than the Basic I/M Performance Standard, and nearly as effective as the Enhanced I/M Performance

[1] In 2002, the area succeeded in attaining the federal standard. This has prompted the preparation of a request to have EPA reclassify the area. This request is accompanied by a maintenance plan, which details how the area will maintain air quality over the next ten years. The major components of the maintenance plan include a commitment to continue the use of reformulated gasoline, continue enhanced vehicle emissions I/M and continue a slightly modified permitting program for construction of air contaminant sources. For more information on this plan, please contact the Missouri Department of Natural Resources, Air Pollution Control Program at (573) 751-4817.

Standard. The Gateway Clean Air Program test data analysis indicates that the enhanced I/M program is effectively reducing exhaust emissions.

Based upon these two analyses, the Air Pollution Control Program makes one recommendation regarding how to increase the enhanced I/M program's effectiveness to meet the Enhanced I/M Performance Standard. The recommendation involves reducing the number of waivers issued to vehicles failing an emission inspection.[2] By reducing the number of waivers issued, more failing vehicles will be fully repaired, which will enable the enhanced I/M program to meet the Enhanced I/M Performance Standard and increase the quantified reductions measured by the Gateway Clean Air Program.

This report also recommends that EPA continue to designate the Gateway Clean Air Program as a federally-approved I/M program and find the I/M portion of the State Implementation Plan[3] approvable.

[2] The state statute and regulations establish a waiver program whereby motorists spending a predetermined minimum amount of money in an attempt to repair a vehicle can be issued a waiver in the event of continued failure. The waiver allows the motorist to register their vehicle despite the fact the vehicle failed the emissions test.

[3] A State Implementation Plan, prepared by the state and subject to EPA approval, identifies actions and programs to be undertaken to control emissions within the state's boundaries.

Acknowledgements

The Gateway Clean Air Program Test Data and Analysis section of this report was drafted by Peter M. McClintock, Ph.D., of Applied Analysis, in consultation with the Department of Natural Resources.

Abbreviations and Definitions

BAR 90 .....California Bureau of Automotive Repair test method implemented in 1990. Also the technical name for a single speed idle tailpipe emission test used in basic I/M programs.

Basic I/M.....A vehicle inspection and maintenance program using a single speed idle tailpipe emission test capable of measuring the concentration of vehicle emissions. Prior to the Gateway Clean Air Program, there was a basic I/M program in place.

CFR.....Code of Federal Regulations. The EPA publishes Title 40 Chapter I Subchapter C Part 51 Subpart S and Part 85 Subpart W, which establish the federal requirements for vehicle emissions I/M programs.

CO.....Carbon Monoxide, one of three pollutants measured during an IM240 test and one of two pollutants measured during a BAR 90 test

Enhanced I/M.....A vehicle inspection and maintenance program using a transient tailpipe emission test capable of measuring the mass of vehicle emissions. The Gateway Clean Air Program uses the IM240 test.

EPA.....United States Environmental Protection Agency

ESP Missouri .....Environmental Systems Products Missouri, the private company awarded the Gateway Clean Air Program contract

gpm .....grams per mile, a mass-based vehicle emissions unit of measurement

GVWR .....Gross Vehicle Weight Rating, specified by the manufacturer as the maximum design loaded weight

HC.....Hydrocarbons, one of three pollutants measured during an IM240 test and one of two pollutants measured during a BAR 90 test. In the case of vehicle emissions, the source of tailpipe and evaporative hydrocarbons is gasoline.

IM240.....A four-minute (240-second) tailpipe emission test that simulates real world driving conditions using a dynamometer in order to more thoroughly evaluate a vehicle's on-road emissions

LDGT1.....MOBILE model version 5b Light Duty Gasoline-Powered Trucks with a GVWR less than 6,001 lbs.

LDGT12.....MOBILE model version 6 Light Duty Gasoline-Powered Trucks with a GVWR less than 6,001 lbs.

LDGT2.....MOBILE model version 5b Light Duty Gasoline-Powered Trucks with a GVWR greater than 6,000 and less than 8,5001 lbs.

LDGT34.....MOBILE model version 6 Light Duty Gasoline-Powered Trucks with a GVWR greater than 6,000 and less than 8,5001 lbs.

LDGV .....Light Duty Gasoline-Powered Vehicles with a GVWR less than 6,001 lbs.

lbs.....pounds

NO_x .....Oxides of Nitrogen, and one of three pollutants measured during an IM240 test

ppm .....parts per million, a concentration-based unit of measurement of vehicle emissions

RFG.....Reformulated Gasoline, a cleaner-burning formula of gasoline containing oxygenates. RFG is a federal requirement for ozone nonattainment areas designated as serious, severe, or extreme, and optional for nonattainment areas designated as marginal or moderate.

RFP .....Request for Proposals, a document released by the state's purchasing division for the purposes of securing the services of a private entity best able to provide the requested services to the state according to the terms of the contract

RSD.....Remote Sensing Device, the technology used to identify vehicles on the road that are running cleanly and do not need to visit an enhanced I/M test station

RSMo .....Revised Statutes of Missouri

SIP.....State Implementation Plan, a binding agreement between a state and the EPA to improve the air quality of a nonattainment area so that it can be redesignated as an attainment area

VMT.....Vehicle Miles Traveled

VOC .....Volatile Organic Compounds, any carbon-based compound that can evaporate into the ambient air. The HCs that make up gasoline are VOCs.

Outline

I. Introduction

The Gateway Clean Air Program was designed to replace the existing basic inspection and maintenance (I/M) program, called the BAR 90 I/M program, which had been established as part of the safety inspection requirement in the 1980s. This change was necessary for several reasons. The technology that was being used to test vehicle emissions, a single speed idle tailpipe test, had become outdated. And an audit conducted by the United States Environmental Protection Agency (EPA) Region VII found that up to 84% of the tests conducted by the decentralized private repair facilities were either fraudulent or done incorrectly.

A centralized, enhanced program alleviates these problems by requiring the use of state-of-the-art testing technology in test-only facilities. No repairs or diagnosis are allowed at such testing facilities. This minimizes the occurrence of fraudulent or incorrect testing and maintains program integrity. With enactment of Senate Bill 590 in 1994, the Missouri Department of Natural Resources was authorized to replace the decentralized basic vehicle emissions I/M program with a centralized enhanced vehicle emissions I/M program. This program is known as the Gateway Clean Air Program.

The enacted statutes, Sections 643.300 to 643.355, Revised Statutes of Missouri (RSMo), are known collectively as the Air Quality Attainment Act and are a direct result of the federal Clean Air Act Amendments of 1990. Missouri faced a 1996 deadline requiring the St. Louis area to come into compliance with the ozone air quality standards of the federal Clean Air Act. The St. Louis area did not meet the 1996 deadline. Between 1994 and 1999, the enhanced I/M legislation lay dormant due to lack of appropriations, legal challenges to the legislation, and state contracting challenges.

The first Request for Proposals (RFP) was released by the state in October 1997. This RFP failed to receive any bids because the requirements of the RFP were not economically feasible. The state released a second redesigned RFP in October 1998. Two companies submitted bids in response to this second RFP. In February 1999, after both bids were evaluated, the state signed a contract with Environmental Systems Products (ESP) Missouri. With Department of Natural Resources oversight, ESP Missouri secured the property, buildings, test equipment and manpower necessary to begin the enhanced I/M program on April 5, 2000 according to the terms of the contract.

This Gateway Clean Air Program Evaluation report verifies that:

1. The enhanced I/M program is meeting the Missouri State Implementation Plan (SIP) **commitment** to EPA to meet the Basic I/M Performance Standard and the SIP **goal** to meet the Enhanced I/M Performance Standard; and

2. Hydrocarbons (HC), also called volatile organic compounds (VOCs), which are emitted by light duty gasoline-powered vehicles and trucks registered and driven primarily in the nonattainment area, are being effectively reduced by the Gateway Clean Air Program. (Hydrocarbons or VOCs are one of the precursors of ground-level ozone, the pollutant of concern in the St. Louis nonattainment area.)

II. Program Evaluation Parameters

A. Nonattainment Area I/M Program Requirements

The St. Louis ozone nonattainment area, made up of St. Louis city and St. Louis, St. Charles, Jefferson, and Franklin Counties, is currently classified by the EPA as a moderate ozone nonattainment area (Appendix A). According to Title 40 of the Code of Federal Regulations (CFR) Section 51.350 (a)(4), moderate ozone nonattainment areas must implement a basic vehicle emissions inspection and maintenance (I/M) program in any urbanized area with a 1990 Census-defined population of 200,000 or more.

The St. Louis ozone nonattainment area has complied with this federal requirement. The Gateway Clean Air Program is made up of two separate vehicle I/M programs. In St. Louis city and St. Louis, St. Charles and Jefferson Counties, a biennial enhanced I/M program is in operation according to the Air Quality Attainment Act state statues, 643.300-643.355, RSMo. In Franklin County, an annual basic I/M program is in operation according to 307.366, RSMo. Because the 1990 Census-based population of Franklin County was less than 200,000, the basic I/M program that began in April 2000 according to state statute 307.366 RSMo will not be evaluated by this program evaluation report.

Although the St. Louis ozone nonattainment area is only required by federal code to implement a basic vehicle emissions I/M program, the state of Missouri elected to implement an enhanced vehicle emissions I/M program in the majority of the nonattainment area for the reasons listed in the Introduction section of this report. Therefore, this report will evaluate the performance of the enhanced I/M portion of the Gateway Clean Air Program relative to the Enhanced I/M Performance Standard established by federal code 40 CFR 51.351, which is Missouri's targeted goal, and the Basic I/M Performance Standard established by federal code 40 CFR 51.352, which is Missouri's binding commitment to EPA. Federal code 40 CFR 51.351 (f)(13) requires enhanced I/M programs to have emission factors within 0.02 gram per mile (gpm) of the Enhanced I/M Performance Standard emission factors. Federal code 40 CFR 51.352 (a)(12) requires Basic I/M programs to obtain the same or lower emission factors as the Basic I/M Performance Standard emission factors.

B. MOBILE Model Versions

Both federal codes 40 CFR 51.351 and 51.352 require states to use the most current version of the EPA mobile source emission factor model, called MOBILE, to calculate the emission factors achieved by a state's I/M program. When Missouri's I/M portion of the SIP was approved by EPA Region VII in May 2000, the most current version of the MOBILE model, version 5b, was used to model the emission factors achieved by the state's enhanced I/M program. However, the most current version of the MOBILE model is now version 6, made available to states in January 2002.

This report will evaluate the performance of the enhanced I/M portion of the Gateway Clean Air Program using both MOBILE model versions 5b and 6 to model the emission factors achieved by the state's enhanced I/M program. The purpose of providing both sets of emission

factors is to demonstrate compliance with Missouri's original SIP commitment to EPA, as well as Missouri's continuing SIP commitment to operate an EPA-approved I/M program. Because version 5b of the MOBILE model is no longer current, future program evaluations will not include an analysis using version 5b of the MOBILE model.

C. Clean Screening

The Gateway Clean Air Program includes an EPA-recognized clean screening element to increase overall motorist convenience. By allowing clean-running vehicles that are identified on the road with remote sensing technology to skip a trip to an enhanced emission test station, fewer vehicles have to visit an enhanced I/M test station. However, a small percentage of the vehicles identified as running cleanly do have emissions that exceed the enhanced I/M test standards. In other words, there is a small air quality benefit reduction for incorporating this motorist convenience element into an I/M program.

Version 5b of the MOBILE model is capable of modeling this air quality benefit reduction. However, version 6 of the MOBILE model is not yet capable of modeling this air quality benefit reduction. Therefore, although both MOBILE model version 5b and 6 analysis is provided, only version 5b analysis includes the small air quality benefit reduction of the clean screening element of the Gateway Clean Air Program.

D. Start-up Standards

Missouri's enhanced I/M program was designed to comply with the federal guidelines established in the August 1998 IM240 & Evap Technical Guidance document, which has since been revised by EPA in April 2000. To avoid overwhelming the local vehicle repair industry, federal code 40 CFR 85.2205 (a) of this guidance recommends the use of Start-up Standards during the first two years of enhanced I/M program operation, followed by the use of Final Standards. These Start-up Standards allow the vehicle repair industry to develop their skills and concentrate their efforts during the first two years on fixing the vehicles with the worst emissions. The Gateway Clean Air Program used these IM240 Start-up Standards from April 2000 through December 2001. Therefore, the MOBILE model analysis is limited to the impact that these Start-Up Standards have had on IM240-tested vehicles. Future program evaluation MOBILE model analysis will model the impact that Final Standards, which were first used in 2002, will have on IM240-tested vehicles.

E. Purge Testing

Missouri's I/M portion of the SIP includes a commitment to conduct purge testing, because purge testing is a part of the Enhanced I/M Performance Standard described in federal code 40 CFR 51.351. Because a non-intrusive purge test has not yet been approved by the EPA, Missouri did not claim any purge testing credit in the EPA-approved I/M portion of the SIP. As a result of EPA removing the purge test standards, procedures, specifications, and quality control practices from the April 2000 revision of the IM240 and Evap Technical Guidance, the capability of modeling the air quality benefit of purge testing was also removed from MOBILE model version 6. Therefore, although both MOBILE model version 5b and 6 Enhanced I/M

Performance Standard analyses are provided, only the MOBILE model version 5b analysis includes the theoretical air quality benefit of purge testing.

F. Other VOC Control Strategies

The St. Louis ozone nonattainment area does employ two other VOC control strategies that can be modeled using the MOBILE model.

1. Refueling Emissions

The first VOC control strategy is the recovery of gasoline vapors at the point of distribution to gasoline-powered vehicles. This Stage II Vapor Recovery program has been in effect in the St. Louis ozone nonattainment area since 1989 and has been a substantial piece of the overall planned reductions included in the Missouri SIP. However, because the Gateway Clean Air Program does not directly impact these refueling emissions, and this report is focused only on the air quality benefit of the enhanced I/M program, the contribution of the Stage II Vapor Recovery program to VOC emission reductions has not been modeled.

2. Reformulated Gasoline

The second VOC control strategy is the federal reformulated gasoline (RFG) program. The RFG program has been in effect in the St. Louis ozone nonattainment area since the state chose to opt into this federal program in May 1999. RFG has also been a substantial piece of the overall planned reductions included in the Missouri SIP. Because RFG burns more cleanly than conventional gasoline in all gasoline-powered vehicles subject to the enhanced I/M program, RFG does reduce the emission levels of vehicles tested by the Gateway Clean Air Program. Therefore, the contribution of RFG to VOC emission reductions has been modeled.

G. BAR 90 I/M Program Comparison

The enhanced I/M program area transitioned from a decentralized BAR 90 I/M program to the Gateway Clean Air Program in January 2000. However, if the Air Quality Attainment Act had not been passed and the Gateway Clean Air Program had not been implemented, the BAR 90 I/M program would have continued, and the emissions of the vehicles in the enhanced I/M program area would have continued to be impacted by this BAR 90 I/M program. This report compares the modeled emission factors achieved by such a scenario with the emission levels achieved by the Gateway Clean Air Program in order to demonstrate that Missouri's air quality has benefited by the transition from the BAR 90 I/M program to the Gateway Clean Air Program.

H. MOBILE Model Month of Evaluation

According to 40 CFR 51.353 (c)(1), states must report the results of their program evaluation to the EPA on a biennial basis, starting two years after the initial start of mandatory testing. Because the Gateway Clean Air Program began mandatory testing in April 2000, and the levels of ozone in the St. Louis nonattainment area have only exceeded the Clean Air Act

health-based standards in the summer months, the emission levels calculated with MOBILE model versions 5b and 6 were calculated for the calendar year 2002 and the month of July.

I. Evaluation of Enhanced I/M Program Data

Federal code 40 CFR 51.353 (c)(2) requires states to establish actual emission reductions achieved from I/M programs. Federal code 40 CFR 51.353 (c)(3) requires states to use, at a minimum, a representative, random sample of at least 0.1 percent of the vehicles and subject these vehicles to a mass emission test using the transient test method, commonly referred to as the IM240 test. 40 CFR 51.353 (c)(4) requires states to use this small sample of IM240 test data to calculate local fleet emission factors in order to assess the effectiveness of the I/M program, and to determine if the relevant performance standard is being met. Because Missouri's Gateway Clean Air Program uses the IM240 test on all 1981 and newer model year vehicles that are tested at an enhanced I/M test station, this report analyzes all available IM240 data. All remaining data from other test methods used by the Gateway Clean Air Program has been converted into IM240 data, so that the actual emission reductions from each test method can be aggregated into initial and final aggregated fleet mass-based emission factors.

J. MOBILE Model and Enhanced I/M Program Data Comparison

The MOBILE model and the Gateway Clean Air Program test data analyses provided in this report are not directly comparable with each other. The MOBILE model analysis is static in time, meaning that all of the MOBILE model scenarios are for one time period. The purpose of this static analysis is to eliminate the impact that unknown variables might have on one or more scenarios. Because of the static nature of MOBILE modeling, it cannot provide a time-lapsed average emission reduction analysis. On the other hand, the Enhanced I/M Program Data analysis is dynamic in time. By considering every initial emission inspection and every final emission inspection within the first two years of Gateway Clean Air Program operation, a time-lapsed average emission reduction analysis can be conducted.

Additionally, the MOBILE model is designed to calculate the emission factors of a fleet of vehicles using multiple assumptions and inputs, only some of which can be controlled by the model inputs, to estimate the impact of all vehicles operating in the affected area through a wide range of operating conditions. The Gateway Clean Air Program test data is based on a limited set of vehicle operating conditions, defined by the test method parameters, applied to a limited set of vehicles. So while both analyses are provided in this report, the results of each analysis must be considered independently.

If the results of both methods of analysis are complementary to each other and meet the goals established in the Introduction section, then the Gateway Clean Air Program will continue to be an EPA-approved I/M program.

III. MOBILE Model Data and Analysis

A. MOBILE Model Inputs

The MOBILE model version 5b and version 6 input files describe five different scenarios (Appendix B).

The first set of input scenarios, Base02.in (version 5b) and 6Base02.in (version 6), model the July 2002 average fleet emission levels assuming that there was no I/M program in operation in the St. Louis ozone nonattainment area. The only VOC emission control strategy in effect for these scenarios is RFG. The following inputs were used to model the base cases:

Average Speed: 19.6 mph
Calendar Year: 2002
Month: 7 (July)

The second set of input scenarios, Bar90.in (version 5b) and 6Bar90.in (version 6), model the July 2002 average fleet emission levels assuming that RFG and the BAR 90 I/M program described in 307.366, RSMo were in effect, and that the enhanced I/M program described in 643.300-643.355, RSMo was not in effect. The following inputs were used to model the BAR 90 I/M program:

Start Year: 1990[4]
Stringency Rate (1971-1980 Model Year Failure Rate): 18%[5]
First Model Year Tested: 1971[6]
Last Model Year Tested: 2000[7]
Pre-1981 Model Year Waiver Rate: 24%[4]
1981+ Model Year Waiver Rate: 21%[8]
Compliance Rate: 96%
Inspection Type: Test and Repair-Computerized (TRC)
Effectiveness: HC – 50%; CO – 50%; NO_x – 0%[9]
Inspection Frequency: Annual
Vehicle Types Tested: Light Duty Gasoline-powered Vehicles (LDGV), Light Duty Gasoline-powered Trucks (LDGT1 or LDGT12) (0-6,000 lbs. Gross Vehicle Weight Rating (GVWR)), Light Duty Gasoline-powered Trucks (LDGT2 or LDGT34) (6,001-8,500 lbs. GVWR)

[4] Although there was a basic I/M program in place prior to 1990, it was a paper-based program (Test and Repair-Manual), which the MOBILE model considers even less effective than a computer-based (TRC) program. Therefore, 1990 was selected as the start year.
[5] The stringency rate of 18% comes from the first two years of Gateway Clean Air Program test data, since the test method and test standards for these 1971-1980 model year vehicles hasn't changed.
[6] Set by Missouri statute 307.366, RSMo.
[7] The last model year tested is 2000 because the first two model years are statutorily exempted from the emission I/M program.
[8] The waiver rates of 24% and 21% come from the first two years of Gateway Clean Air Program test data, since the waiver requirements for these vehicles did not change when the Gateway Clean Air Program started.
[9] The MOBILE 5b model assumes that test and repair I/M programs are only half as effective as test only I/M programs, unless data can support a higher effectiveness. Given the EPA's audit findings described in the Introduction section, the effectiveness of the BAR 90 I/M program was not assumed to any greater than 50% of a test only I/M program. In addition, the BAR 90 I/M program did not test vehicles for NO_x emissions.

Emission Test Type: Single Speed Idle
Emission Standards: HC – 220 ppm; CO – 1.2%; NO_x – N/A
Average Speed: 19.6 mph
Calendar Year: 2002
Month: 7 (July)

The third set of input scenarios, BPerfStd.in (version 5b) and 6BPerf02.in (version 6), model the July 2002 average fleet emission levels assuming that RFG and the Basic I/M Performance Standard, described in federal code 40 CFR 51.352, were in effect. This Basic I/M Performance Standard is the standard against which the EPA is required to measure the Gateway Clean Air Program. The following inputs were used to model the Basic I/M Performance Standard:

Start Year: 1983
Stringency (1971-1980 Model Year Failure Rate): 20%
First Model Year Tested: 1968
Last Model Year Tested: 2020[10]
Pre-1981 Model Year Waiver Rate: 0%
1981+ Model Year Waiver Rate: 0%
Compliance Rate: 100%
Inspection Type: Test Only (T/O)
Inspection Frequency: Annual
Vehicle Types Tested: LDGV only
Emission Test Type: Single Speed Idle
Emission Standards: HC – 220 ppm; CO – 1.2%; NO_x – N/A
Average Speed: 19.6 mph
Calendar Year: 2002
Month: 7 (July)

The fourth set of input scenarios, GCAPpt.in and GCAPnopt.in (version 5b) and 6GCAP02.in (version 6), model the actual performance of the Gateway Clean Air Program. Because of the way MOBILE model version 5b models the impact of gas cap testing, two input files are necessary to model the actual performance of the Gateway Clean Air Program using MOBILE model version 5b. The following inputs were used to model the enhanced I/M portion of the Gateway Clean Air Program:

Start Year: 2000
Stringency Rate (1971-1980 Model Year Failure Rate): 18%
First Model Year Tested: 1971
Last Model Year Tested: 1980
Pre-1981 Model Year Waiver Rate: 24%
1981+ Model Year Waiver Rate: 21%
Compliance Rate: 96%
Inspection Type: Test Only (T/O)
Inspection Frequency: Biennial
Vehicle Types Tested: LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34

[10] The Performance Standard scenarios do not provide an ending model year. Any model year after the year of interest, in this case 2002, can be used.

Emission Test Type: Single Speed Idle
Emission Standards: HC – 220 ppm; CO – 1.2%; NO_x – N/A
First Model Year Tested: 1981
Last Model Year Tested: 2000
Pre-1981 Model Year Waiver Rate: 24%
1981+ Model Year Waiver Rate: 21%
Compliance Rate: 96%
Inspection Type: Test Only (T/O)
Inspection Frequency: Biennial
Vehicle Types Tested: LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34
Emission Test Type: Transient (IM240)
Emission Standards: HC – 0.8 gpm; CO – 15 gpm; NO_x – 2.0 gpm
Clean Screening Input File[11]
Technician Training and Certification Input File[12]
No Anti-Tampering Testing[13]
Evaporative System Pressure Testing[14]: 2000 Start, 1981-2000 Model Years, LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34, Test Only, Biennial, 96% Compliance Rate
No Purge Testing[15]
Average Speed: 19.6 mph
Calendar Year: 2002
Month: 7 (July)

The fifth set of input scenarios, EPerfStd.in (version 5b) and 6EPerf2p.in (version 6), model the Enhanced I/M Performance Standard, using IM240 Start-up Standards, described in federal code 40 CFR 51.351. This Enhanced I/M Performance Standard is the standard that the Gateway Clean Air Program was designed and is striving to meet. The following inputs were

[11] This MOBILE model version 5b input file models the impact of exempting 40% of the vehicles from a station-based test using model year exemptions and remote sensing technology. Because a small percentage of the clean screened vehicles will not be clean, this input file decreases the air quality benefit of the enhanced I/M program.

[12] Missouri statute 643.335, RSMo requires motorists who want the cost of a repair technician's labor to count towards the waiver minimum spending requirements to seek out repair facilities that employ technicians that are Recognized. In order to be a Recognized Repair Technician, the technician must be employed full time, pass three standardized tests offered by the National Institute for Automotive Service Excellence (ASE) and take a four-hour Gateway Clean Air Program course. Because this requirement increases the repair effectiveness of the I/M program, this input file increases the air quality benefit of the enhanced I/M program.

[13] Missouri does conduct an anti-tampering inspection on all vehicles that fail a tailpipe emission or gas cap test. However, the MOBILE model guidelines only allow the modeling of anti-tampering testing if it is conducted on every vehicle. Therefore, the air quality benefit of this test method has not been modeled for the purpose of this program evaluation.

[14] Full evaporative system pressure testing consists of a test of the gas cap (40%) and the fuel vapor trapping system (60%). Because the Gateway Clean Air Program conducts only the gas cap portion of the evaporative system pressure test, two different scenarios must be modeled, one with the evaporative system pressure test in use, and one with the evaporative system pressure test not in use. Then, 40% of the HC credit for the evaporative system pressure test scenario must be added to the scenario without the evaporative system pressure test to calculate the impact of the gas cap testing element.

[15] Currently, there is not a non-intrusive purge test that has been approved by the EPA and required to be used. So, although Missouri has committed to conducting a purge test in its SIP, no such test is being conducted, and the air quality benefit of this test method has not been modeled for the purpose of this program evaluation.

used to model the Enhanced I/M Performance Standard:

Start Year: 1983
Stringency Rate (1971-1980 Model Year Failure Rate): 20%
First Model Year Tested: 1968
Last Model Year Tested: 1985
Pre-1981 Model Year Waiver Rate: 3%
1981+ Model Year Waiver Rate: 3%
Compliance Rate: 96%
Inspection Type: Test Only (T/O)
Inspection Frequency: Annual
Vehicle Types Tested: LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34
Emission Test Type: Single Speed Idle
Emission Standards: HC – 220 ppm; CO – 1.2%; NO_x – N/A
First Model Year Tested: 1986
Last Model Year Tested: 2020
Pre-1981 Model Year Waiver Rate: 3%
1981+ Model Year Waiver Rate: 3%
Compliance Rate: 96%
Inspection Type: Test Only (T/O)
Inspection Frequency: Annual
Vehicle Types Tested: LDGV, LDGT1, LDGT2
Emission Test Type: Transient (IM240)
Emission Standards: HC – 0.8 gpm; CO – 20 gpm; NO_x – 2.0 gpm
No Clean Screening
No Technician Training and Certification
Anti-Tampering Testing: 1983 Start, 1968-2020 Model Years, LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34, Test Only, Annual, 96% Compliance Rate, Visual Inspection of Catalytic Converter, Fuel Inlet Restrictor, Exhaust Gas Recirculation system, Evaporative system, Positive Crankcase Ventilation valve, and Gas Cap
Evaporative System Pressure Testing: 1983 Start, 1983-2020 Model Years, LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34, Test Only, Annual, 96% Compliance Rate
Purge Testing[16]: 1983 Start, 1986-2020 Model Years, LDGV, LDGT1 or LDGT12, LDGT2 or LDGT34, Test Only, Annual, 96% Compliance Rate
Average Speed: 19.6 mph
Calendar Year: 2002
Month: 7 (July)

B. MOBILE Model Outputs

The MOBILE model version 5b and version 6 output files (Appendix C) provide local fleet emission factors for the five input scenarios described above.

C. MOBILE Model Version 5b Analysis

[16] Purge testing can only be modeled with MOBILE model version 5b.

In order to accurately compare the five different scenarios described above, the MOBILE model outputs from version 5b must be compared only with each other and not with the MOBILE model outputs from version 6. This analysis compares the MOBILE model version 5b outputs.

The MOBILE model calculates emission factors for each vehicle type that is on the road, including light duty gasoline-powered vehicles and trucks, heavy duty gasoline-powered trucks, light and heavy duty diesel-powered vehicles and trucks, and motorcycles. However, Missouri's enhanced I/M program impacts only light duty gasoline-powered vehicles and light duty gasoline-powered trucks with a gross vehicle weight rating under 8,501 lbs.[17] Therefore, the comparisons of the five scenarios consider only the vehicle miles traveled (VMT)-weighted average of the calculated LDGV, LDGT1 or LDGT12, and LDGT2 or LDGT34 emission factors.

The enhanced I/M program reduces three types of tailpipe exhaust pollution: hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x). The enhanced I/M program also reduces one type of non-exhaust pollution: evaporated hydrocarbons (HC) trapped within the fuel system.

The VMT-weighted average of the calculated LDGV, LDGT1 and LDGT2 exhaust emission factors are listed in Table 3.1 for each MOBILE model version 5b scenario. The VMT-weighted average of the calculated LDGV, LDGT1 and LDGT2 non-exhaust emission factors are listed in Table 3.2 for each MOBILE model version 5b scenario. The results of Tables 3.1 and 3.2 are graphed in Figure 3.1 and 3.2, respectively, below.

Table 3.1 – MOBILE 5b LDGV, LDGT1, and LDGT2 Exhaust Emission Factors

Scenario Description	**Exhaust HC**	**Exhaust CO**	**Exhaust NO_x**
Base Case (No I/M)	1.25 gpm	16.48 gpm	1.33 gpm
Base Case (BAR 90 I/M)	1.14 gpm	15.06 gpm	1.30 gpm
Basic I/M Performance Standard	1.11 gpm	14.59 gpm	1.32 gpm
Gateway Clean Air Program	0.81 gpm	10.37 gpm	1.02 gpm
Enhanced I/M Performance Standard	0.72 gpm	9.66 gpm	1.01 gpm

Table 3.2 – MOBILE 5b LDGV, LDGT1, and LDGT2 Non-Exhaust Emission Factors

Scenario Description	**Non-Exhaust HC**
Base Case (No I/M)	0.45 gpm
Base Case (BAR 90 I/M)	0.45 gpm
Basic I/M Performance Standard	0.45 gpm
Gateway Clean Air Program	0.41 gpm
Enhanced I/M Performance Standard	0.27 gpm

[17] These light duty gasoline-powered vehicles and trucks make up 88.1% of the MOBILE model version 5b vehicle miles traveled in the enhanced I/M area.

Figure 3.1 – MOBILE 5b LDGV, LDGT1, and LDGT2 Exhaust Emission Factors

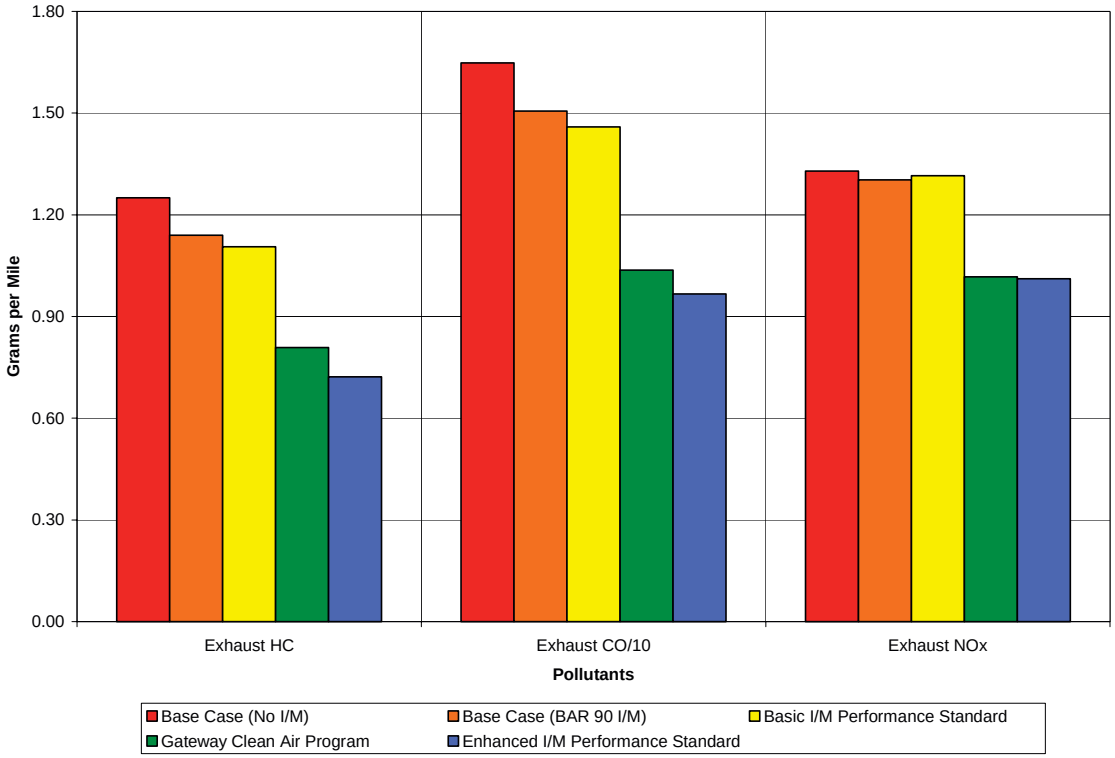
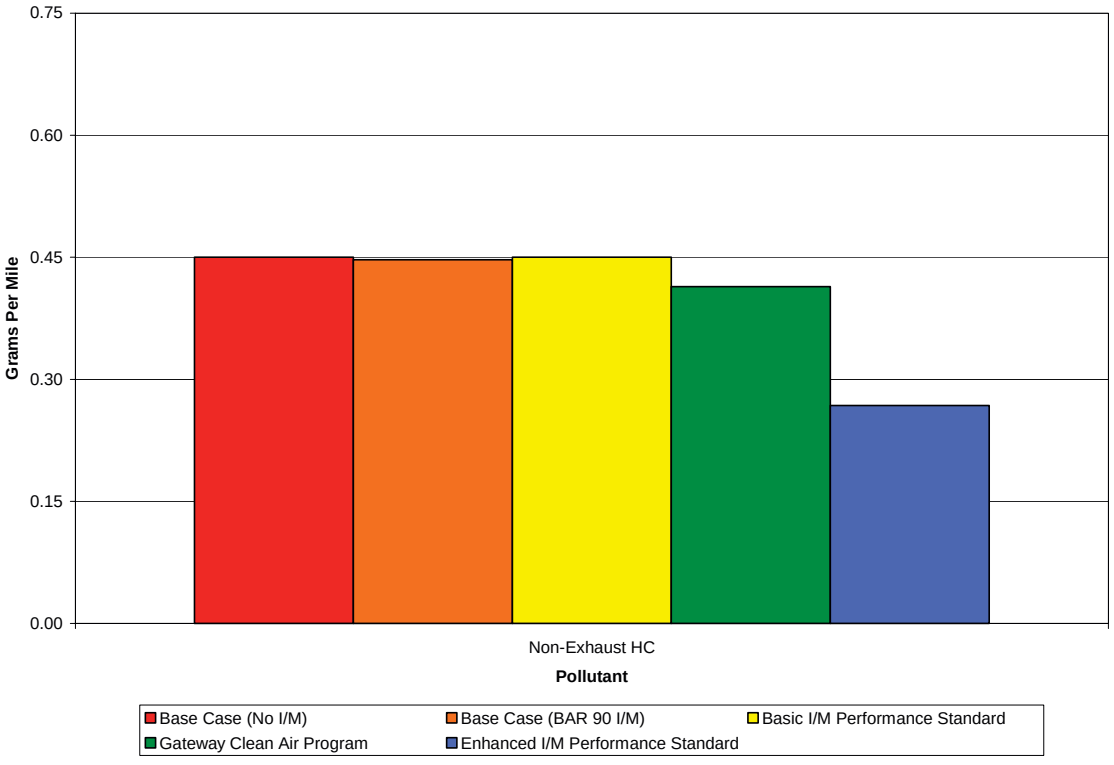


Figure 3.2 – MOBILE 5b LDGV, LDGT1, and LDGT2 Non-Exhaust Emission Factors



Based upon MOBILE model version 5b modeling, the Gateway Clean Air Program scenario emission factors (the green bars in Figures 3.1 and 3.2) are less than the Basic I/M Performance Standard scenario emission factors (the yellow bars in Figures 3.1 and 3.2) for Exhaust HC, CO, and NO_x and Non-Exhaust HC. Therefore, the Gateway Clean Air Program has met the requirement in federal code 40 CFR 51.352 (a)(12) and is fulfilling Missouri's binding commitment with the EPA.

Based upon MOBILE model version 5b modeling, the Gateway Clean Air Program scenario emission factors are less than the Base Case (No I/M) scenario emission factors (the red bars in Figures 3.1 and 3.2) and the Base Case (BAR 90 I/M) (the orange bars in Figures 3.1 and 3.2) scenario emission factors for Exhaust HC, CO, and NOx and Non-Exhaust HC. Therefore, the Gateway Clean Air Program is more successful at reducing the contribution that light duty gasoline-powered vehicles and trucks make to St. Louis area ozone formation when compared with the scenarios where no vehicle emission I/M program is in place or where the previous BAR 90 I/M program has continued unchanged.

Based upon MOBILE model version 5b modeling, the Gateway Clean Air Program scenario emission factors are greater than the Enhanced I/M Performance Standard scenario emission factors (the blue bars in Figures 3.1 and 3.2) for Exhaust HC, CO, and NOx and Non-Exhaust HC. Therefore, the Gateway Clean Air Program has not yet achieved the requirement in federal code 40 CFR 51.351 based upon MOBILE model version 5b modeling.

There are many logical reasons that the MOBLE model version 5b analysis does not show the Gateway Clean Air Program achieving the Enhanced I/M Performance Standard, which is Missouri's targeted goal:

1. The Enhanced I/M Performance Standard includes purge testing, which is not currently technically feasible.
2. The Enhanced I/M Performance Standard does not include clean screening, which has increased the motorist convenience of the Gateway Clean Air Program, but does result in a small benefit reduction.
3. The Enhanced I/M Performance Standard includes full evaporative system pressure testing, which is a more invasive, time-consuming test. The Gateway Clean Air Program conducts only the gas cap test portion of the full evaporative system pressure test, which is not invasive and less time-consuming.
4. The Enhanced I/M Performance Standard models an annual I/M program requirement, which is less convenient than the Gateway Clean Air Program's biennial I/M program requirement.
5. The Enhanced I/M Performance Standard models an I/M program that began in 1983 and tests 1968 and newer model year vehicles, excluding the first model year. The Gateway Clean Air Program began in 2000 and tests 1971 and newer model year vehicles, excluding the first two model years.
6. The Enhanced I/M Performance Standard models an anti-tampering I/M program element conducted on every vehicle. The Gateway Clean Air Program only conducts an anti-tampering I/M program element on those vehicles that fail a tailpipe or gas cap test.
7. The Enhanced I/M Performance Standard models an I/M program that grants a waiver to

no more than three percent of the initially failed vehicles. During the first two years of operation, the Gateway Clean Air Program has granted a waiver to 24 percent of the initially failed 1971-1980 model year vehicles and 21 percent of the initially failed 1981 and newer model year vehicles.

The Gateway Clean Air Program is designed to maximize air quality benefits and motorist convenience, two goals that do not always easily overlap. The Gateway Clean Air Program has endeavored to find the right balance between these two goals. The Gateway Clean Air Program emission factors are less than the Basic I/M Performance Standard emission factors. The EPA is measuring the Gateway Clean Air Program against the Basic I/M Performance Standard emission factors. Therefore, continuation of the motorist convenience elements that are keeping the Gateway Clean Air Program from attaining the Enhanced I/M Performance Standard are creating benefits outweighing the failure to attain the Enhanced I/M Performance Standards, justifying continuation of the motorist convenience elements of the program.

Despite all of the reasons that the MOBLE model version 5b analysis does not show the Gateway Clean Air Program achieving the Enhanced I/M Performance Standard, the Gateway Clean Air Program is only 0.09 gpm above the Exhaust HC Enhanced I/M Performance Standard, 0.14 gpm above the Non-Exhaust HC Enhanced I/M Performance Standard, 0.71 gpm above the Exhaust CO Enhanced I/M Performance Standard, and 0.01 gpm above the Exhaust NO_x Enhanced I/M Performance Standard. In other words, the balance between air quality and motorist convenience is in need of only a small adjustment. Considering the seven reasons listed above for failing to meet the Enhanced I/M Performance Standard, the most expedient change to improve the program would be a reduction in the waiver rate. By reducing the 24 and 21 percent waiver rates to lower levels[18], more vehicles will be fully repaired, thereby improving air quality, and fewer vehicles will need to be retested, thereby improving overall motorist convenience.

D. MOBILE Model Version 6 Analysis

This analysis compares the MOBILE model version 6 outputs. The VMT-weighted average of the calculated LDGV, LDGT12 and LDGT34 running exhaust emission factors[19] are listed in Table 3.3 for each MOBILE model version 6 scenario. The VMT-weighted average of the calculated LDGV, LDGT12 and LDGT34 non-exhaust emission factors are listed in Table 3.4 for each MOBILE model version 6 scenario. The results of Tables 3.3 and 3.4 are graphed in Figure 3.3 and 3.4, respectively, below.

[18] The enhanced I/M waiver rate stated in Missouri's EPA-approved SIP is 8.0%. Federal code 40 CFR 51.360 (d)(2) requires states to take corrective action if the actual waiver rate exceeds the waiver rate committed to in the SIP. An amendment to the enhanced I/M waiver requirements goes into effect in January 2003 that will significantly lower the current waiver rate. Future program evaluation reports will analyze the impact of this amendment upon the enhanced I/M waiver rate.

[19] These light duty gasoline-powered vehicles and trucks make up 87.0% of the MOBILE model version 6 vehicle miles traveled in the enhanced I/M area. Start exhaust emissions have been ignored because I/M programs are not specifically designed to reduce this type of exhaust emissions.

Table 3.3 – MOBILE 6 LDGV, LDGT12, and LDGT34 Running Exhaust Emission Factors

Scenario Description	**Exhaust HC**	**Exhaust CO**	**Exhaust NO_x**
Base Case (No I/M)	0.485 gpm	12.27 gpm	1.119 gpm
Base Case (BAR 90 I/M)	0.449 gpm	11.64 gpm	1.092 gpm
Basic I/M Performance Standard	0.443 gpm	11.55 gpm	1.106 gpm
Gateway Clean Air Program	0.358 gpm	10.30 gpm	0.972 gpm
Enhanced I/M Performance Standard	0.341 gpm	10.34 gpm	0.949 gpm

Table 3.4 – MOBILE 6 LDGV, LDGT12, and LDGT34 Non-Exhaust Emission Factors

Scenario Description	**Non-Exhaust HC**
Base Case (No I/M)	0.605 gpm
Base Case (BAR 90 I/M)	0.605 gpm
Basic I/M Performance Standard	0.605 gpm
Gateway Clean Air Program	0.594 gpm
Enhanced I/M Performance Standard	0.581 gpm

Figure 3.3 – MOBILE 6 LDGV, LDGT12, and LDGT34 Exhaust Emission Factors

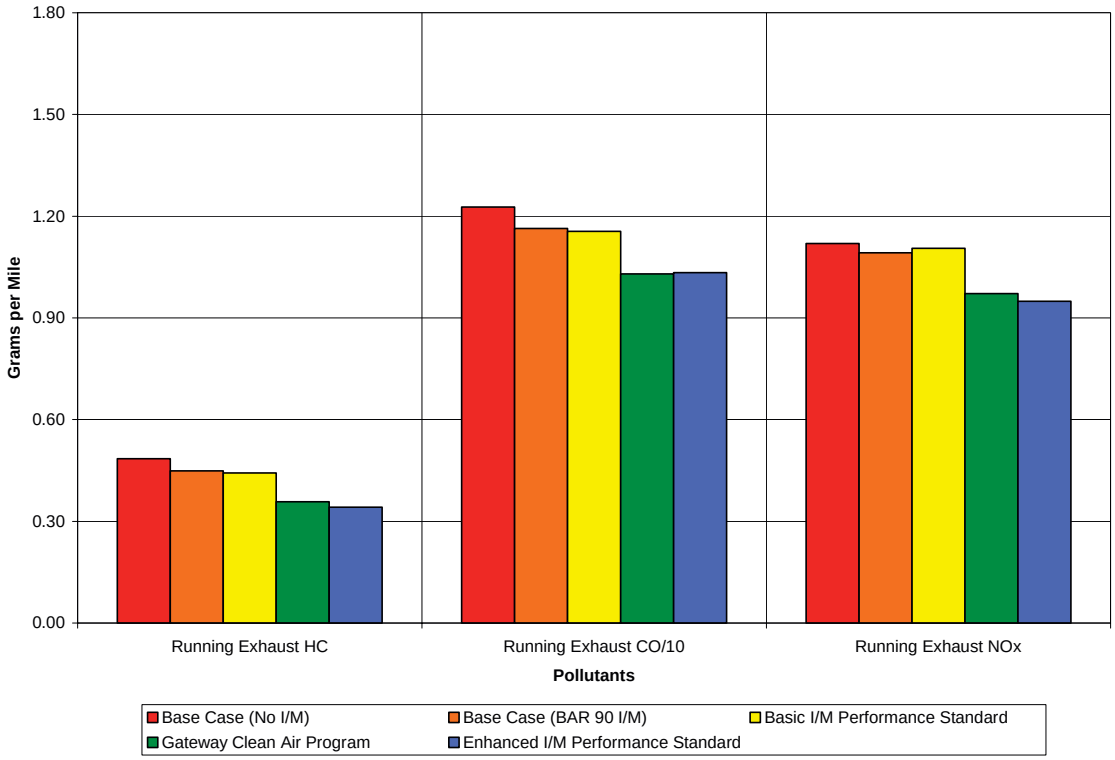
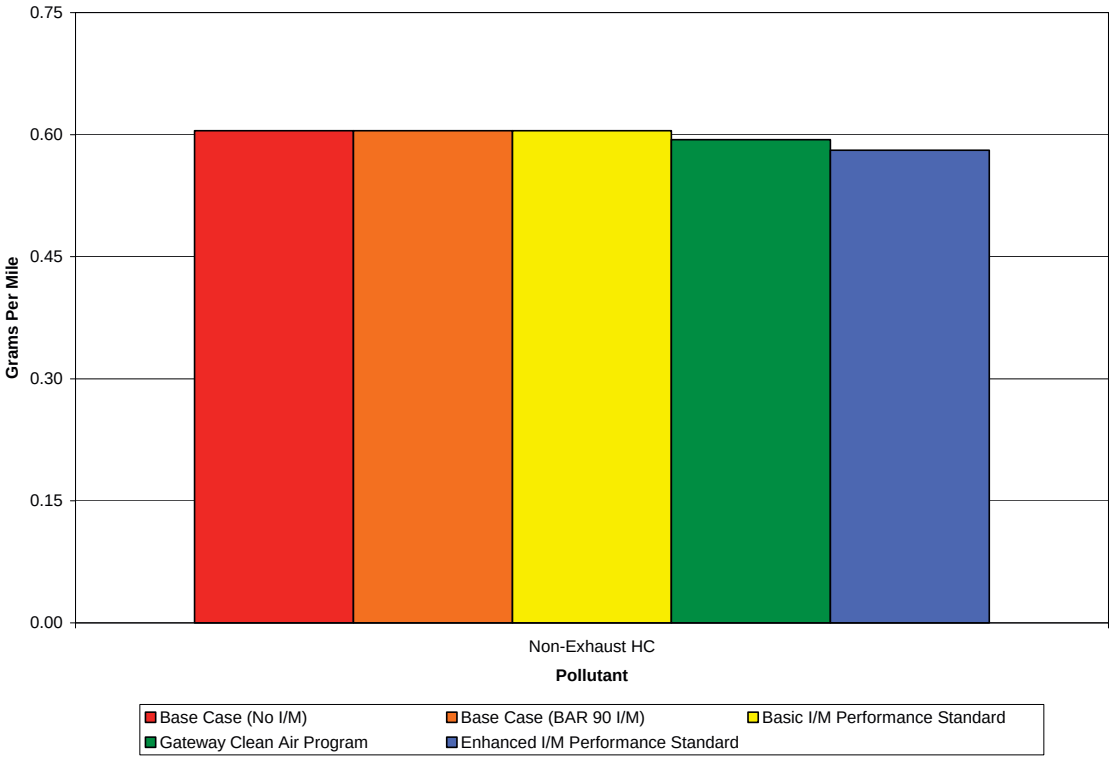


Figure 3.4 – MOBILE 6 LDGV, LDGT1, and LDGT2 Non-Exhaust Emission Factors



Based upon MOBILE model version 6 modeling, the Gateway Clean Air Program scenario emission factors (the green bars in Figures 3.3 and 3.4) are less than the Basic I/M Performance Standard scenario emission factors (the yellow bars in Figures 3.3 and 3.4) for Running Exhaust HC, CO, and NO_x and Non-Exhaust HC. Therefore, the Gateway Clean Air Program has met the requirement in federal code 40 CFR 51.352 (a)(12) and is fulfilling Missouri's binding commitment with the EPA.

Based upon MOBILE model version 6 modeling, the Gateway Clean Air Program scenario emission factors are less than the Base Case (No I/M) scenario emission factors (the red bars in Figures 3.3 and 3.4) and the Base Case (BAR 90 I/M) scenario emission factors (the orange bars in Figures 3.3 and 3.4) for Running Exhaust HC, CO, and NO_x and Non-Exhaust HC. Therefore, the Gateway Clean Air Program is more successful at reducing the contribution that light duty gasoline-powered vehicles and trucks make to St. Louis area ozone formation when compared with the scenarios where no vehicle emission I/M program is in place or where the previous BAR 90 I/M program has continued unchanged.

Based upon MOBILE model version 6 modeling, the Gateway Clean Air Program scenario emission factors are either slightly greater than or slightly less than the Enhanced I/M Performance Standard scenario emission factors (the blue bars in Figures 3.3 and 3.4) for Running Exhaust HC, CO and NO_x and Non-Exhaust HC. The Gateway Clean Air Program is 0.017 gpm above the Running Exhaust HC Enhanced I/M Performance Standard, 0.04 gpm below the Exhaust CO Enhanced I/M Performance Standard, 0.023 gpm above the Running Exhaust NO_x Enhanced I/M Performance Standard, and 0.013 gpm above the Non-Exhaust HC Enhanced I/M Performance Standard. Because all of the Gateway Clean Air Program emission factors are within the 0.02 gpm tolerance allowed by the Enhanced I/M Performance Standard, the Gateway Clean Air Program has achieved the requirement in federal code 40 CFR 51.351[20].

E. Enhanced I/M Emission Reductions

The MOBILE model analysis provided in this section is not designed to quantify the emission reductions achieved by the Gateway Clean Air Program. The static analysis is designed to quantify the relative effectiveness of five different I/M scenarios, ranging from no I/M program to the Enhanced I/M Performance Standard. Only by analyzing the enhanced I/M program data can the Gateway Clean Air Program emission reductions be quantified. This analysis is provided in the next section.

[20] MOBILE model version 6 is not yet capable of modeling the impact of clean screening on emission factors. Therefore, the Gateway Clean Air Program emission factors may, in fact, be larger than those stated, which would in turn affect the determination that the Gateway Clean Air Program has achieved the Enhanced I/M Performance Standard.

IV. Gateway Clean Air Program Test Data and Analysis

The Gateway Clean Air Program uses three test types at the enhanced I/M test stations:

- IM240 – Transient test, applicable to 1981 and newer model year vehicles
- TSI – Two Speed Idle test, applicable to 1981 and newer model year vehicles that cannot be safely tested with an IM240 test
- SSI – Single Speed Idle test, applicable to 1971 to 1980 model year vehicles

Vehicles may fast-pass the IM240 test after 30 seconds. All vehicles that fail IM240 run the full 240 seconds of the test. Those failing within two times the composite standard are given a second chance IM240 test.

This Program Evaluation report analyzes the first two years of operation of the Gateway Clean Air Program, from April 5, 2000, to December 31, 2001. Data used in the analyses in this report are primarily drawn from the I/M test database maintained on the ESP Missouri host computer system. The Vehicle Test Record table within the I/M test database contains emissions test result information for each type of test for all vehicles inspected.

A. Methodology Used to Determine Tailpipe Emission Factors

Using the actual measurements for each vehicle inspected, the following steps are used to estimate local fleet tailpipe emission factors:

1. Determine the initial and final tailpipe emissions for each vehicle tested
2. Convert TSI and SSI Test Results to IM240-equivalent gpm emission factors

B. Categorizing Initial and Final Tailpipe Emissions

In order to evaluate the Gateway Clean Air Program emission factors, vehicle test results were sorted by VIN, test date and time. Vehicles were then further classified into one of four categories, Passed, Repaired, Unresolved, and Waived, based on their first and last test result during the period of evaluation. Interim results were ignored. In the list below, the first and last results are indicated in parenthesis, where "P" is pass, "F" is fail, "W" is waiver and "Null" indicates that there was only a single test result for a particular vehicle. The expected combinations that apply to the vast majority of vehicles are in bold.

1. Passed – Passed initial test (**P/Null**, P/P, P/F, P/W)
2. Repaired – Failed and successfully repaired (**F/P**)
3. Unresolved – Failed unresolved (**F/Null**, **F/F**)
4. Waived – Failed and wavered (**F/W**)

The difference between the initial and final tests is used to determine the percentage of tailpipe emissions reduction of each group. For vehicles with only one test, the final result is the same as the initial result.

C. Adjustment of IM240 Fast-Pass Results

To allow for comparison of emissions of vehicles tested over different durations of the IM240 test cycle, the emission results for vehicles that fast-pass the IM240 inspection must be extrapolated. During the IM240 test, the highest gram per mile values occur at second 30 and decrease as the test continues. Gram per mile emissions are highest at the beginning of the test for two reasons. First, some vehicles may not have been properly preconditioned prior to testing, so that their engines and catalytic converters are not fully warmed up, resulting in higher emissions at the start of the test. The emissions of these vehicles decrease once the engine and converter are hot. Second, the first part of the IM240 test simulates urban driving, while the second part simulates highway driving. The mass of tailpipe emissions per mile are higher over the first part of the IM240 cycle.

Several methods have been developed for estimating full test values from fast-pass IM240 test results. The Lawrence Berkeley Livermore Laboratory (LBNL) method developed by Tom Wenzel[21] has been used here. The LBNL method is based on a sample of second-by-second emissions of 4,000 vehicles given the full IM240 in Arizona in 1992. The gpm emissions were calculated for each vehicle for each second of the test, by dividing the cumulative grams of emissions over the cumulative distance driven at each second of the test. The gpm emissions for each second were then averaged over the entire sample. The ratio is calculated of the emissions at each second to the emissions for the full IM240, for each pollutant for each vehicle. The adjustment factors are as high as three for vehicles passed immediately after 30 seconds. Each of the adjustment factor curves reaches unity at second 240. The adjustments are greater for HC and CO emissions than for NOx emissions. The simplicity of the LBNL method allows it to be applied to stored IM240 test results.

The conversion of fast-pass results to a full 240 second test result has considerable potential for introducing error into the estimated emissions inventory of vehicles that fast-pass their emissions test because the LBNL method did not separate passing and failing vehicles in determining the appropriate multiplier. If passing vehicles perform relatively better on the second part of the IM240 than failing vehicles, which is likely, then the method is likely to overestimate the emissions of clean vehicles. Failing vehicles all receive at least one full 240-second test and many receive two. Therefore, their initial failing emissions do not need to be extrapolated and are less subject to error.

The effect of overestimating the emissions of clean vehicles is to overestimate the total fleet emissions and consequently to underestimate the percentage of reductions. In future years, a random sample of full 240-second test results on vehicles that fast-pass may be used to verify and improve the accuracy of the fast-pass to 240-second test projection.

D. Vehicles with Waivers

[21] Wenzel, T. "Converting Fast Pass/Fast Fail Emissions Results to Full IM240 Equivalents", LBNL Report, August 2000.

The inspection records for the waiver transaction do not contain tailpipe emission test results. The final emissions data used for these vehicles are, therefore, the results from the last tailpipe emissions inspection preceding the waiver. The reductions shown for these vehicles may not always reflect the final repairs made to the vehicle after it is waived and may therefore understate the Gateway Clean Air Program emission reductions.

E. First and Final Emissions Results

When vehicles fail their initial inspection, they must obtain a repair and return for re-inspection. This process is normally completed in 30 days, but can take longer. To avoid overstating the number of vehicles that have not completed the repair process, the initial and final matching process selects initial tests conducted from April 5, 2000, through December 31, 2001, and final tests conducted from April 5, 2000, through February 28, 2002. This allows 60 days for vehicles to have completed their test and repair cycle, which should be the majority of those that will complete the cycle.

A number of vehicles do not complete the repair-reinspection process. In most cases, these vehicles are either scrapped or removed from the nonattainment area, which does reduce emissions. Surveys in Arizona[22] and Colorado[23] have found that some vehicles continue to operate in the area in violation of the program rules, either with expired license plates or with stolen license plates or license plate stickers. In this report, it is assumed that two-thirds of these unresolved vehicles leave the area and one third continue to operate illegally in the area.

Table 4.1 contains an example of the initial and final tailpipe results for 1981 to 1984 passenger vehicles inspected using the IM240 test. The table shows the average initial and average final emissions for each group of vehicles together with the percentage reduction.

For example, of the 1,886 1981 model year passenger vehicles tested using the IM240 transient test, 16.0% of vehicles initially failed inspection and were repaired (Passed) with a 65% to 70% reduction in HC and CO and an 18% reduction in NOx. Another 9.0% of vehicles failed their initial inspection and had not successfully passed a retest by February 28, 2002 (Unresolved). Reductions from these vehicles are estimated to be approximately 67% for HC, CO and NOx, because two thirds are assumed to have left the area and the remaining one third have modest reductions. Finally, 11.8% of vehicles received a waiver (Waived), and the measured reductions prior to the waiver were 14.0% HC, 7.7% CO and 5.4% NOx. In aggregate, including vehicles that passed their initial inspection, 1981 passenger vehicle emissions were reduced 34.7% for HC, 34.1% for CO and 10.4% for NOx.

Complete tables by test type, model year and vehicle type are provided in Appendix D.

[22] Wenzel, T. “Evaluation of Arizona’s Enhanced I/M Program.” Presented at the 9th CRC On-Road Vehicle Emissions Workshop. April 1999.

[23] McClintock, P. “The Denver Remote Sensing Clean Screening Pilot”, ESP report for the Colorado Department of Health, December 1999.

Table 4.1 Transient Test Emission Reductions for 1981-1984 Passenger Vehicles

Appendix D1 IM240 Test Emissions Reductions

Unresolved fails remaining in area 33%

Model Year/Type	First Result	Last Result	Vehicles		Initial HC	Initial CO	Initial NOX	Final HC	Final CO	Final NOX	Reduction % HC	Reduction % CO	Reduction % NOX
1981	Pass	-	1,192		0.85	12.85	2.05	0.85	12.85	2.05	0.0%	0.0%	0.0%
P	Fail	Pass	302	16.0%	2.95	52.74	2.43	1.01	15.66	1.98	65.6%	70.3%	18.4%
	Fail	Unresolv.	169	9.0%	6.52	101.63	2.30	2.18	34.82	0.75	66.5%	65.7%	67.6%
	Fail	Waiver	223	11.8%	5.92	101.84	2.39	5.09	94.02	2.26	14.0%	7.7%	5.4%
Total	Fail%		1,886	36.8%	2.30	37.72	2.17	1.50	24.87	1.95	34.7%	34.1%	10.4%
1982	Pass	-	1,801		0.84	11.53	2.36	0.84	11.53	2.36	0.0%	0.0%	0.0%
P	Fail	Pass	341	13.4%	3.14	53.16	2.69	0.96	13.51	2.27	69.3%	74.6%	15.8%
	Fail	Unresolv.	175	6.9%	6.44	94.11	2.36	2.21	32.62	0.74	65.7%	65.3%	68.8%
	Fail	Waiver	231	9.1%	5.11	85.71	2.69	4.62	78.01	2.60	9.6%	9.0%	3.3%
Total	Fail%		2,548	29.3%	1.92	29.50	2.44	1.30	19.27	2.26	32.6%	34.7%	7.2%
1983	Pass	-	3,115		0.84	9.85	2.38	0.84	9.85	2.38	0.0%	0.0%	0.0%
P	Fail	Pass	561	13.0%	2.80	45.06	2.55	0.91	11.01	2.36	67.4%	75.6%	7.7%
	Fail	Unresolv.	306	7.1%	5.40	95.72	2.16	1.76	31.81	0.73	67.4%	66.8%	66.1%
	Fail	Waiver	331	7.7%	5.72	85.50	2.49	5.28	80.97	2.41	7.7%	5.3%	3.4%
Total	Fail%		4,313	27.8%	1.79	26.33	2.40	1.25	17.02	2.26	30.0%	35.4%	5.6%
1984	Pass	-	6,636		0.81	9.25	2.35	0.81	9.25	2.35	0.0%	0.0%	0.0%
P	Fail	Pass	1,028	11.8%	2.77	47.05	2.56	0.91	10.58	2.32	67.2%	77.5%	9.3%
	Fail	Unresolv.	501	5.7%	5.43	84.97	2.53	1.74	27.77	0.83	67.9%	67.3%	67.0%
	Fail	Waiver	562	6.4%	4.84	86.39	2.30	4.41	83.73	2.25	8.9%	3.1%	2.0%
Total	Fail%		8,727	24.0%	1.57	23.02	2.38	1.11	15.27	2.26	29.3%	33.7%	5.4%

F. Convert Idle Test Tailpipe Concentrations to IM240 Equivalent Grams per Mile

Remote sensing measurements are used to correlate idle test values to IM240-equivalent values. This is done in three steps:

1. Compare Idle test results of vehicles to their on-road remote sensing values;
2. Compare on-road remote sensing emissions of vehicles to their IM240 test emissions;
3. Combine the results from 1. and 2. to convert Idle test values to equivalent IM240 test values.

1. Idle Test Results vs. Remote Sensing Values

Figure 4.1 plots the on-road emissions measurements of vehicles against their enhanced idle test results. Each point shows the average emissions of one model year of vehicles. The resulting emission trend line is not linear and has been fitted to a power equation. The correlation equations for HC and CO are shown in Table 4.2. There is no correlation equation for NO_x, because the idle test does not measure NO_x emissions.

Figure 4.1 Enhanced Idle vs. Remote Sensing HC

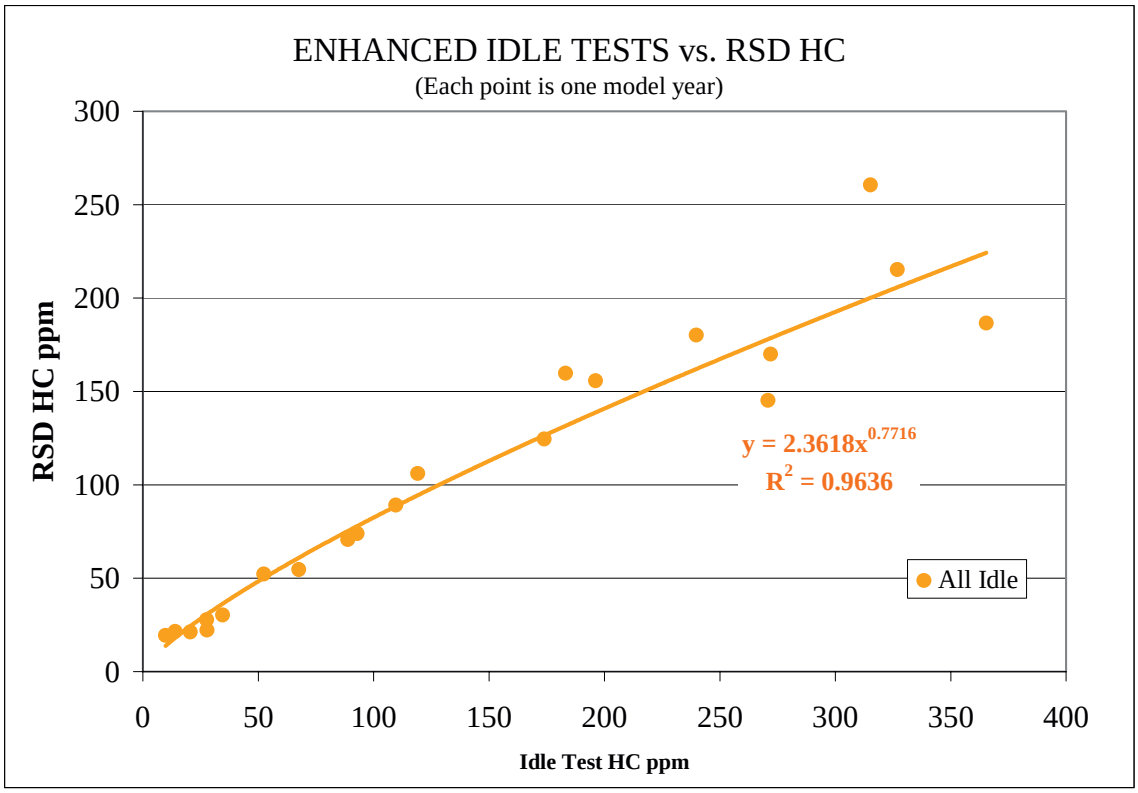


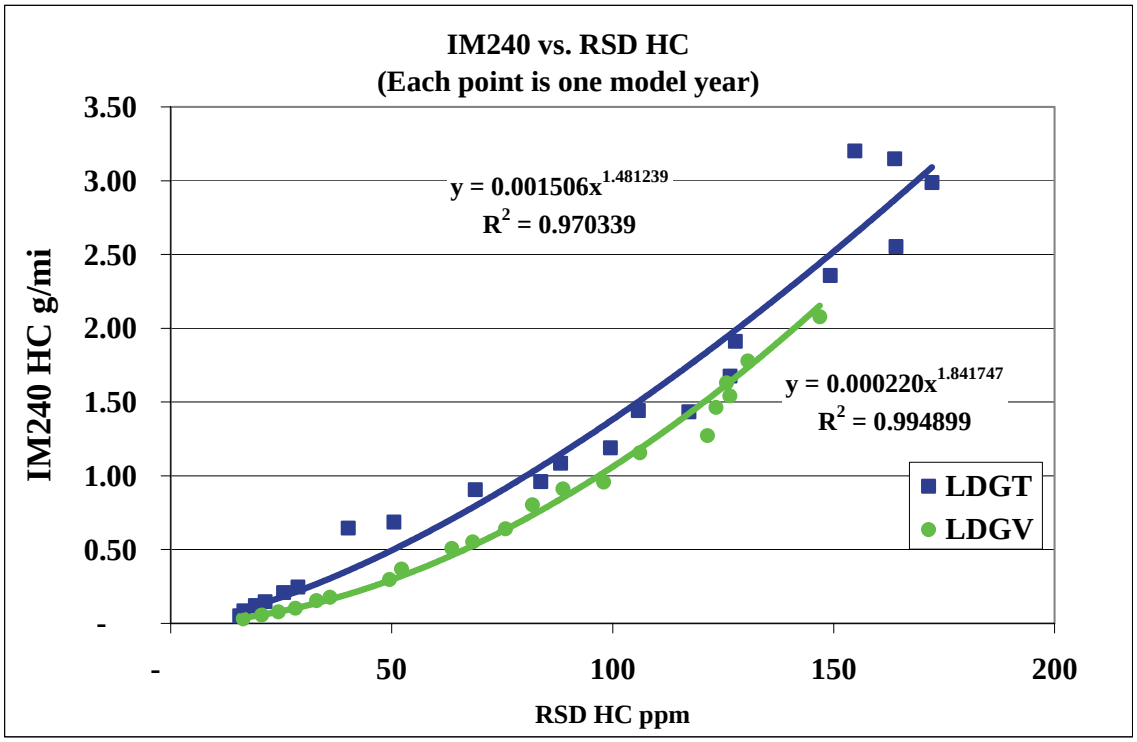
Table 4.2 Enhanced Idle vs. RSD Correlation

RSD HC ppm = 2.3618 x (Enhanced Idle HC ppm)$^{0.7716}$
RSD CO % = 1.4197 x (Enhanced Idle CO %)$^{0.8514}$

2. IM240 Test Results vs. Remote Sensing Values

Figure 4.2 shows a similar plot of average IM240 HC emissions for each model year vs. the average on-road HC emissions. In this case, trucks (LDGT) have been separated from passenger vehicles (LDGV) because of the difference in the nature of the mass emissions measured by the IM240 test and the emission concentrations measured by remote sensing. The mass of emissions produced for a given concentration depends in part on the weight and shape of the vehicle. Heavier, less aerodynamic trucks have higher mass emissions for a given concentration than lighter more streamlined passenger vehicles. This is reflected in the separation of the two trend lines.

Figure 4.2 IM240 vs. Remote Sensing HC



The correlation equations for HC and CO are shown in Table 4.3.

Table 4.3 IM240 vs. RSD Correlation

LDGV: IM240 HC gpm = 0.00022 x (RSD HC ppm)$^{1.84175}$
LDGT: IM240 HC gpm = 0.001506 x (RSD HC ppm)$^{1.48124}$
LDGV: IM240 CO gpm = 21.836 x (RSD CO %)$^{1.2086}$
LDGT: IM240 CO gpm = 23.872 x (RSD CO %)$^{1.0428}$

3. IM240 emissions vs. Idle emissions

The equations in Tables 4.2 and 4.3 are combined to yield the equations shown in Table 4.4 that are used to convert Idle test results to IM240 equivalent values.

Table 4.4 IM240 vs. Idle Correlation

LDGV: IM240 HC gpm = .001071 (Enhanced Idle HC ppm)$^{1.421094}$
LDGT: IM240 HC gpm = .005379 (Enhanced Idle HC ppm)$^{1.142925}$
LDGV: IM240 CO gpm = 33.352 (Enhanced Idle CO %)$^{1.0290}$
LDGT: IM240 CO gpm = 34.403 (Enhanced Idle CO %)$^{0.8878}$

G. Fleet Composite Emissions Factors

The actual average emissions of the entire vehicle fleet are of interest because the MOBILE model calculates average emission factors of the entire fleet. The emissions of exempt new vehicles and RapidScreen vehicles are weighted into the results from the tests conducted at enhanced I/M stations to determine emission factors for the total fleet.

A limited number of 2002 model vehicles and a larger number of 2001 model vehicles were tested at stations during calendar years 2000 and 2001. The average initial emissions of the 2001 model vehicles that were tested have been used to represent the emissions of new exempt vehicles. The number of new exempt vehicles in the enhanced I/M area was estimated to be 109,146 per year[24].

A two percent random sample of vehicles qualifying for RapidScreen exemption are set aside for testing at stations. The average initial emissions from this random audit sample are used to represent the average emissions of the vehicles exempt from testing through the RapidScreen program. The number of unique vehicles obtaining a RapidScreen and no station tests in the two year period is 247,795. These were pro-rated between the enhanced and basic I/M program areas to give an enhanced I/M area estimate of 243,715 vehicles.

Table 4.5 summarizes the emission factors of the vehicles comprising the enhanced I/M fleet and calculates the VMT-weighted average tailpipe emissions. This table does not include non-exhaust HC emission factors because the gas cap test data is not a test method that provides quantitative emission results. Therefore, the initial and final gas cap test data cannot be compared.

[24] According to Missouri Department of Revenue Division of Motor Vehicle and Drivers Licensing registration data, 218,291 new gasoline-powered vehicles potentially subject to the emission inspection requirement were registered between January 2000 and December 2001. For the purposes of this program evaluation report, the registration data was assumed to be evenly distributed between these two calendar years.

Table 4.5 Enhanced I/M Fleet Aggregated Emission Factors

Test Type	Annual Miles	Unique Vehicles	Daily VMT ('M)	Initial IM240 g/mi			Final IM240 g/mi		
				HC	CO	NOx	HC	CO	NOx
Enhanced Idle	8,183	52,880	1.19	1.98	23.81	N/A	1.27	19.21	N/A
Enhanced IM240	10,871	786,326	23.42	0.50	5.81	1.18	0.42	4.72	1.16
RapidScreen 2000	12,188	132,849	4.44	0.28	3.12	0.92	0.28	3.12	0.92
RapidScreen 2001	12,694	110,866	3.86	0.31	3.39	0.95	0.31	3.39	0.95
Exempt pass	14,542	158,424	6.31	0.03	0.51	0.15	0.03	0.51	0.15
Exempt truck	19,272	59,868	3.16	0.05	0.97	0.27	0.05	0.97	0.27
Fleet Aggregate	11,885	1,301,213	42.37	0.40	4.66	0.90	0.33	3.93	0.89

H. Enhanced I/M Emission Reductions

Because the average initial and final exhaust emission factors are available, the dynamic difference between these two emission factors represents the Gateway Clean Air Program air quality benefit on a fleet wide basis. Table 4.6 quantifies this reduction.

Table 4.6 Enhanced I/M Fleet Average Emission Factor Reductions

Pollutant	Difference (gpm)	Difference (%)
Exhaust HC	0.07	17.5 %
Exhaust CO	0.73	15.7 %
Exhaust NO_x	0.01	1.1 %

Based upon this Gateway Clean Air Program Test Data analysis, the enhanced I/M program is reducing the fleet wide average exhaust emission factors.

V. Conclusions

Even though the MOBILE model and the Gateway Clean Air Program Test data analyses are not directly comparable, given the differences in their assumptions and methods of analysis, Table 5.1 lists the emission factors generated by the MOBILE model version 6 Enhanced I/M Performance Standard scenario, listed in Table 3.3, and the calculated Gateway Clean Air Program Enhanced I/M Fleet Average emission factors, listed in Table 4.5.

Table 5.1 MOBILE 6 and Enhanced I/M Fleet Aggregated Emission Factors

Pollutant	MOBILE 6 Enhanced I/M Performance Standard (gpm)	Enhanced I/M Fleet Average Emission Factors (gpm)
Exhaust HC	0.341	0.33
Exhaust CO	10.34	3.93
Exhaust NO_x	0.949	0.89

A. MOBILE Model Data Conclusions

Based upon the MOBILE 5b analysis provided, the Gateway Clean Air Program enhanced I/M element has met the Basic I/M Performance Standard and is very close to meeting the Enhanced I/M Performance Standard. Based upon the MOBILE 6 analysis provided, the Gateway Clean Air Program enhanced I/M element has met both the Basic and the Enhanced I/M Performance Standards.

B. Gateway Clean Air Program Test Data Conclusions

Based upon the Gateway Clean Air Program test data analysis provided, the Gateway Clean Air Program is effectively reducing the tailpipe VOC emissions of light duty gasoline-powered vehicles and trucks. Because the Gateway Clean Air Program is also testing gas caps, the Gateway Clean Air Program is also reducing the evaporative VOC emissions of light duty gasoline-powered vehicles and trucks, although the effectiveness of this reduction is not quantified in this report.

C. Program Evaluation Report Recommendations

Based upon these two analyses, the Gateway Clean Air Program can increase the enhanced I/M program's effectiveness so that it is as effective as the Enhanced I/M Performance Standard if it can reduce the number of waivers issued to vehicles that initially fail an emission inspection. By doing so, more failing vehicles will be fully repaired or removed from the nonattainment area, which will enable the enhanced I/M program to meet the Enhanced I/M Performance Standard and increase the quantified reductions measured by the Gateway Clean Air Program.

Based upon the entire report, the Missouri Department of Natural Resources recommends that EPA Region VII continue to designate the Gateway Clean Air Program as a federally-approved I/M program and find the I/M portion of the Missouri SIP approvable.